CALIFORNIA DIVISION OF MINES AND GEOLOGY
FAULT EVALUATION REPORT FER-198

GROUND CRACKS NEAR THE GARLOCK FAULT IN SEARLES VALLEY, SAN BERNARDINO COUNTY

by
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INTRODUCTION

The Garlock fault is a major, active, left-lateral fault that separates the Basin and Range geologic province to the north from the Mojave Desert province to the south. Active traces of the Garlock fault on the SE ¼ Searles Lake 15-minute quadrangle (Spangler Hills East 7.5-minute quadrangle) were included within Alquist-Priolo Special Studies Zones in 1976 based on the work of Clark (1973) supplemented by mapping of Smith (1964). In 1976 all Quaternary faults were zoned, but since that time the criteria of "sufficiently active" has been re-interpreted to include only Holocene faults. Faults which were zoned in 1976 but do not meet the current criteria of "sufficiently active and well defined" (Hart, 1988) are recommended for removal from Special Studies Zones.

Ground cracks began forming in 1970 in the Searles Valley, approximately 5 km north of the Garlock fault (Figure 1). These were originally described as extensional fissures and not thought to be related to faulting (Zellmer and others, 1985). The fissures enlarged during a thunderstorm in 1983 and a new zone of left-stepping en echelon cracks formed shortly thereafter. Zellmer and others concluded that the cracks are due to tectonic stresses associated with the Garlock fault. Because the ground cracks mapped by Zellmer and others affect the Randsburg Wash Access Road, they are evaluated here for possible zoning under the Alquist-Priolo Special Studies Zones Act.

SUMMARY OF AVAILABLE DATA

The Garlock fault forms the northern boundary of the Mojave Desert physiographic province for over 250 km from the San Andreas fault on the west to the Death Valley fault zone on the east. The zone is clearly active with abundant evidence for Holocene movement (Clark, 1973). Searles Valley is located north of the Garlock fault in the Basin and Range geologic province. The valley is underlain by Pleistocene and Holocene lacustrine and alluvial sediments (Smith, 1964; Zellmer and others, 1985).

Extensional cracks were first noticed in 1970 north of the Randsburg Wash Access Road on the China Lake Naval Weapons Center

(Figure 1) (Zellmer and others, 1985). This zone of cracks was greatly enlarged during a thunderstorm in 1983. A second zone, branching off from the first at about 30° formed shortly after the thunderstorm (Figure 2) (Zellmer and others, 1985). This second zone of cracks trends approximately N17°W and consists of left-stepping en echelon cracks.

The en echelon cracks and 32 mm of right-lateral offset of the access road suggest a tectonic origin. Zellmer and others (1985) examined several alternative explanations for the cracks, including landsliding, subsidence, desiccation, and piping. They concluded that the cracking probably occurred due to either distributed tectonic stresses in the surficial sediments or a fault at depth. Desiccation and piping are ruled out by the en-echelon cracking; landsliding by the very low slope; and subsidence by the absence of nearby pumping wells.

The tectonic interpretation is favored by Zellmer and others (1985) for several reasons. The area is known to have high rates of historic deformation (Smith and Church, 1980). Very recent tectonic cracks have been observed by Clark (1973) on the Garlock fault east of the Spangler Hills East quadrangle. The cracks are similar in form to those formed along the Coyote Creek fault due to the 1968 Borrego Mountain earthquake (Clark, 1972). Perhaps most important, the extensional fissure is oriented perpendicular to the tensional strain vector measured by Savage and others (1973) on the Garlock fault. The left stepping en echelon cracks are oriented about 30° to the extensional cracks, the orientation a right lateral shear would be expected from the stress field.

Zellmer and others (1984, 1985) also inspected excavations of the ground cracks. They determined that multiple episodes of ground cracking had occurred at the same location but do not mention any vertical or horizontal offsets.

A possibility not considered by Zellmer and others (1985) is that the original cracks formed due to desiccation and that the later, en echelon cracks formed due to the incipient collapse of the wall of the original fissure. Movement of the block between two fissures toward the open, extensional fissure would have caused parallel fractures at the other side of the block. If these fractures were localized on a pre-existing zone of weakness at an angle to the extension, they would have formed an en echelon set of fractures. In this way, previously existing desiccation fissures could have formed a series of fault-like (en echelon) surface cracks.

REVIEW OF AERIAL PHOTOGRAPHS

Aerial photographs taken by the U.S.D.A. in 1953 and the U.S.G.S. in 1966 were examined by this writer to verify previously mapped traces of the Garlock fault and to check for geomorphology related to faulting in the area of ground cracking. No field checking was done for this study.

Previously mapped traces of the Garlock fault that were verified are marked with a check on Figure 3. Those that were not verified as active faults are marked NV. Generally, those traces mapped by Clark (1973) were the active traces of the Garlock fault. Some traces mapped by Clark appeared to be mislocated when they were transferred to the Spangler Hills 7½' quadrangle. This is probably largely due to the poor quality of the old Searles Lake 15' quadrangle. Many of the strands mapped by Smith (1964) do not appear to have Holocene displacement (Figure 3). Clark's mapping is shown on Figure 4 but has been adjusted slightly to conform to the new base map.

No geomorphology suggestive of recent faulting was observed in the area of ground cracks. Previously existing fissures were also not observed.

CONCLUSIONS

Traces of the Garlock fault mapped by Clark (1973) show clear evidence of Holocene activity. Smith (1964) shows most of the same traces and several additional traces which are probably not active (Figure 3).

Ground cracks mapped by Zellmer and others (1984, 1985) have orientations consistent with the regional stresses and have offset the ground surface right laterally 32 mm. A tectonic origin, as proposed by Zellmer and others (1985), seems unlikely for the following reasons: 1) extensional fissure formation occurred over a period of at least 13 years but right lateral movement occurred only immediately following a major rainstorm. 2) the right lateral fractures terminate at the extensional fissure and indicate movement of the narrow wedge bounded by the two fracture sets toward the open fissure. The ground cracks are, however, faults where they displace the ground surface. These faults, whether or not they are of tectonic origin, represent a surface rupture hazard and are sufficiently active and well defined for zoning.

RECOMMENDATIONS

Selected traces of the Garlock fault mapped by Clark (1973) in the Spangler Hills East quadrangle shown on Figure 4 should be included within Alquist-Priolo Special Studies Zones. This will require only slight modification of the zone boundaries on the SW ¼ Searles Lake quadrangle. Older faults of Clarke (1973) and faults of Smith (1964) are not recommended for zoning.

Ground cracks mapped by Zellmer and others (1985) are clearly active and may be fault related (Zellmer and others, 1985). Although questions can be raised about the origin of these cracks, they do represent a surface rupture hazard. They should be included within a Special Studies Zone. References cited on the zones map should be Clark, (1973); Zellmer and others (1985); and this FER.

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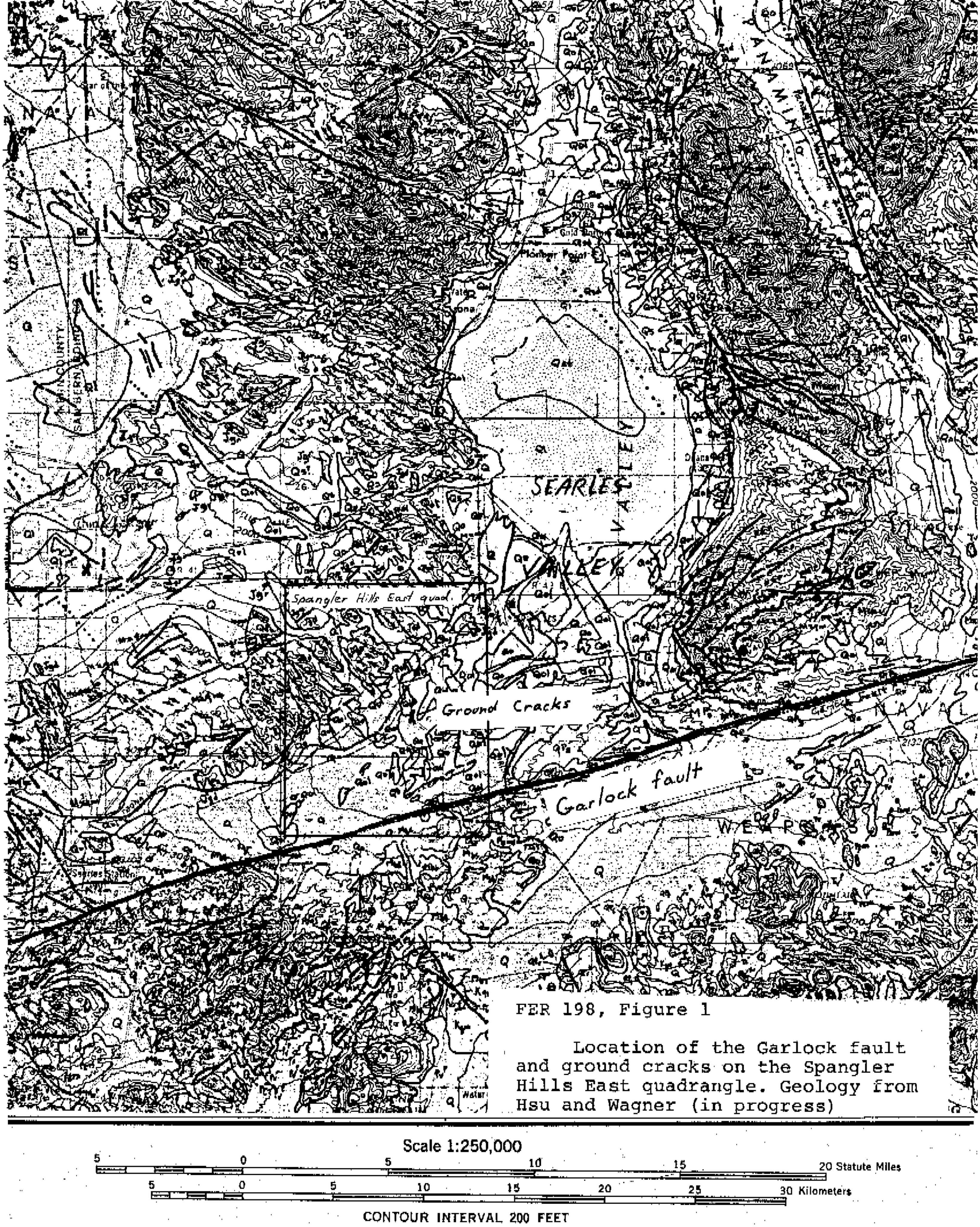
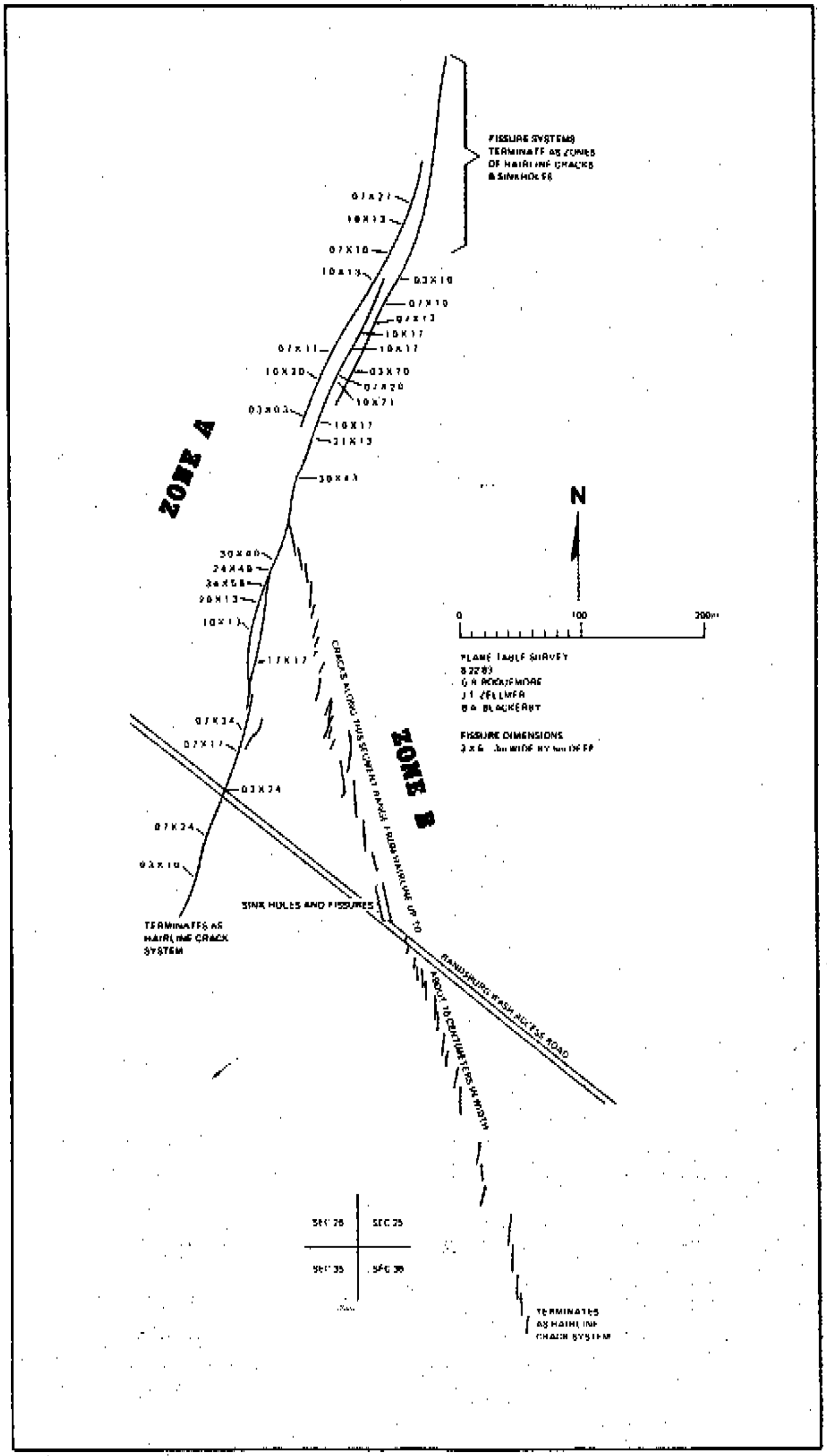


FER 198, Figure 1

Location of the Garlock fault and ground cracks on the Spangler Hills East quadrangle. Geology from Hsu and Wagner (in progress)



FER 198 Figure 2. Plane table map of Zones A and B, showing the orientations and morphologies of the cracks and older fissures.
from Zellmer and others (1984).